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fertility; while the report published by the University of Illinois gives the total stock of every important element of fertility in every type of soil and also gives the results obtained from the addition of different kinds of fertility in different forms, especially in the most economical and profitable forms for use in permanent systems of soil improvement, including farm manures and the use of leguminous crops (which constitute the farmers' natural means of securing nitrogen from the inexhaustible supply in the air), ground natural limestone (which is not caustic in its action, does no damage to the soil, and which is the most economical form of lime to use in normal conditions), and either steamed bone meal (originally a farm product) or fine-ground natural rock phosphate, a still more economical form of phosphorus, which can be secured at sufficiently low prices from the nearby deposits in Tennessee to enable Illinois farmers and landowners positively to enrich their soils in that very important element. Magnesium is also supplied in natural dolomitic limestone, and potassium is liberated from the soil where the natural supply is essentially inexhaustible; or on certain abnormal soils, such as peaty swamp land, soluble potassium salts are used with large profit.

Several additional county soil reports are now in process of preparation, printing or lithographing, and hereafter the publication of the reports is expected to keep pace with the soil survey, which it is hoped will cover the remainder of the State within the next ten or twelve years.

SCOTT'S SECOND ANTARCTIC EXPEDITION*

BY

EDWIN SWIFT BALCH

On March 31, 1912, the *Terra Nova* returned to Akaroa, New Zealand, from her relief voyage to Captain Robert Falcon Scott's expedition in East Antarctica. The *Terra Nova* thus has come out of the Antarctic ice later than any ship heretofore, so late in fact that some students of Antarctic conditions had given up expecting her home this year. She brings back important news of Scott's work, and although the results can hardly be analyzed as yet ex-

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The *Bulletin* has not printed an Antarctic chart with Mr. Balch's papers on the Amundsen and Scott Expeditions because it will not be possible to indicate their routes and the position of their discoveries till their maps are published. It is suggested that readers of these papers consult, for purposes of orientation, Antarctic charts such as are found in the last edition of the Century Atlas (Sheet 3½) or the charts in the Stieler, the Andree, and the E. Debes Atlases.

cept in a preliminary way, a brief summary of the work may be attempted.

Scott sailed in the fall of 1910 in the *Terra Nova*, and after a voyage through Ross Sea, where he met Amundsen at the Bay of Whales, he landed with a strong party at McMurdo Sound. Here a basal winter camp was established, nearly in the same locality where he himself and also Shackleton had wintered before.

As soon as Scott was installed ashore, he proceeded south, starting on February 8, 1911, on a depot laying trip. This proved to be hard work. The snow surface of the Barrier was soft in places, and there were some heavy blizzards. In one of the blizzards two of the ponies succumbed. On February 16, in 79° 30′ S., Scott laid down over one ton of stores in a cache, which was called One Ton Camp. On their return, one of the dog teams went through a bridge on a crevasse, falling sixty feet. By sheer luck, none of the men went down, and only one of the dogs was killed.

On February 24, 1911, Scott and some others started again to lay down more stores. They encountered another tremendous blizzard, from which the ponies suffered severely. On their return some of the party were forced, on account of the tired condition of the ponies, to camp on some sea ice not far from the winter quarters. During the night the ice broke up and began to move. With infinite difficulty the sledges were dragged over the pack, the ponies jumping from floe to floe. Finally the party neared the Barrier, and Crean was able to climb up and go for assistance. With Alpine ropes the men and the sledges and their loads were pulled up on to the Barrier, but nothing could be done for the ponies, and three of the best were lost. From this occurrence as well as from the one mentioned before it may be inferred that ponies are not entirely suitable for Antarctic work. Another cause militating against their use is the fact that, when killed, they cannot be eaten by the other ponies, thus entailing a loss to the commissariat department of the gravest nature under Antarctic conditions.

Between January 27 and March 15, 1911, another party made a long scientific excursion to the westward. This party, consisting of Debenham, Wright, Evans, Griffiths and Taylor, is spoken of as the Western party. After laying down a depot at Cathedral Rocks near the Farrar Glacier, they sledged all about this neighborhood and then returned back by way of the Koettlitz Glacier, of which also they made a careful study. This party made some of the most important scientific observations obtained by the expedition, and these will be spoken of further in this article.

The winter was spent much in the usual way. The hut proved comfortable, and its arrangements for lighting, heating, ventilation, and cooking were eminently satisfactory. The stable for the ponies and the shelter for the dogs also worked well. Every one was fully occupied with scientific and station work, exercising animals, etc. A series of lectures was organized and football was played to within a month of midwinter. The average temperature at the station was below —40° F., at the lowest —50° F. The wind averaged 15 miles an hour, but sometimes blew hard with the temperature at —30° F.

During the winter a journey was made by Wilson, Bowers, Cherry and Garrard, to Cape Crozier to observe the incubation of the emperor penguins at their rookery. They started on June 27 and were absent five weeks. This first winter Antarctic journey taxed the men's powers of endurance to the utmost. On the Barrier the temperatures were seldom above —70° F., the lowest observed with a sling thermometer being —77° F. The storms were terrific. On one occasion a tent and other carefully secured articles were blown away, and, after straining for fourteen hours, the roof of the shelter hut flew to ribbons. In spite of the dangers, darkness, and cold, however, the party were able to reach the rookery, and to secure some eggs at different stages of development, which should give considerable information regarding the embryology of the emperors.

The so-called Northern party, consisting of Campbell, Levicky, Priestly, Abbott, Browning and Dickerson, was picked up on January 4, 1912, at Cape Adare by the *Terra Nova* on her voyage south. They were landed on January 8, at Terra Nova Bay. Hence they proposed to work due north between Mount Melbourne and the Nansen range proceeding as far as time allowed with the object of examining the extreme northeastern land plateau, both geographically and geologically. The *Terra Nova* on its northward voyage tried to take this party on board again but was not able to do so. They were provisioned and equipped, however, in view of this possible emergency arising, and are to proceed south, a distance of about 200 miles, to the winter quarters at McMurdo Sound.

Scott himself started south on November 2 or 12, 1912, bound for the South Pole. He passed the abandoned motors of the advance party which he caught up at 80° 30′ S. Evidently motor sledges have not developed as yet sufficiently to meet quite successfully the conditions of Antarctic travel. Although they dragged heavy loads over the Barrier and crossed crevasses in safety, yet the motors, although cooled by Antarctic zephirs, got overheated, and time and conditions did not permit of the defects being taken in hand.

After the return of the motor party, Scott pushed on steadily south over the Barrier, killing his ponies one after the other for food for the dogs. The weather was bad, snowstorms frequent, the sky continually overcast, and land rarely visible. On December 10, 1911, they were in 83° 15′ S., near Mount Hope, at the foot of the Beardmore Glacier. Traveling up this was terribly hard work. The lower reaches were filled with soft snow, into which men on foot sank in to the knee at each step. It was necessary to do all the pulling on skis. The runner surface of the sledges proved inadequate, and these frequently sank in to the cross-bars, requiring to be extricated with standing pulls. Working from ten to eleven hours, they could only advance about five miles a day. Higher up, the going became better, and the party made better time.

On December 21, they were in 85° 7′ S., 163° 4′ E., at a height of about 6,800 feet. On Christmas day they were close to 86° S., at a considerably higher altitude. On New Year's Eve, in 86° 56′ S., they made another cache, and the seamen of the party rebuilt the sledges with new short runners under the most adverse conditions. On January 4, 1912, the last return party under command of Lieutenant Evans, bade Scott farewell in 87° 35′ S., at an altitude of 9,800 feet, and left him struggling forward to the South Pole. With Scott were Dr. Wilson, Captain Oates, Lieutenant Bowers, and Petty Officer Evans. They had a month's provisions and were excellently equipped. They have doubtless, let us hope, after attaining the South Pole for the second time, long since returned to their winter quarters.

On the return journey of the last supporting party, which reached 87° 35′ S., Lieutenant Evans, commanding the party, developed a bad case, the only one on the expedition, of the much dreaded disease scurvy. Owing to the party being short handed, Evans was compelled to continue pulling the sledge. His condition became more serious daily, until finally he was unable to stand. His companions thereupon dragged him to within thirty miles from winter quarters, to which Crean then made a forced march alone, and brought back Dr. Atkinson. Evans' life was thus saved, but he had to be invalided back to New Zealand where he is now convalescent. It seems strange that with all modern medical knowledge there should still be danger of scurvy in the Polar regions. It is said to be a form of ptomaine poisoning, and doubtless comes from the canned food which unfortunately must, to some extent, still be resorted to.

Much scientific work and many observations were carried out by the various members of the expedition. Self-registering meteorological instruments have given a continuous record of the pressure of temperature within the neighborhood of McMurdo Sound. The upper atmosphere was investigated by means of small balloons, which have shown the direction of upper currents to a height of six miles and temperatures up to five miles. An almost unbroken record of magnetic elements was obtained, and absolute magnetic observations were made every week. All through the winter the aurora was observed every hour, but few brilliant displays occurred. Atmospheric electricity also was studied. Pendulum observations for finding the value of gravity were carried out, and a tide gauge has given a continuous record.

Geology has received much attention. Problems regarding the origin of Alpine topography when Europe and other temperate regions were undergoing the Ice Age, are being studied in the examples offered by retreating glaciers in South Victoria Land, where this age still obtains. Above the Farrar Glacier, Debenham discovered a distinct crater of the late glacial age, also late basalt flows eighty feet thick: confirmation of the already known fact that there has been much volcanic activity in Antarctica. In the same neighborhood, the western party passed at one place a fresh water lake, frozen only at the surface. They also found a valley, described as a dry valley, where the glacier had apparently melted away before the rays of the sun. Near Granite Harbor, specimens of bituminous coal were found, also by Debenham, which were almost certainly derived from a well marked outcrop of beacon sandstone on the nunatak. This coal is of economic value and appears to be the second find of coal in the Antarctic, the first apparently being that made by Mr. Wild of Shackleton's expedition, who in 85° S., discovered seams of coal from four inches to eight feet in thickness with sandstone intervening.

Near the Mackay Glacier numerous well preserved fossils, probably crustacean, were found, which in connection with the several finds of fossils already made in Antarctica, tend to show that at one time life was more abundant there than now.

Biological work has been carried on steadily. Much was done at a hole kept open in the sea ice during the winter, where minute organisms were observed. Parasites of seals, of penguins and other birds, and of fish have been studied. Some new protozoa have been found. On the *Terra Nova,* some trawling was carried out, through which a collection of the deep sea fauna of Ross Sea was made.

At Granite Harbor, thousands of wingless insects of two different species were observed clustering under the pebbles. The existence of insects in Antarctica was first revealed by Mr. Henryk Arctowski of de Gerlache's expedition, who discovered a tiny one in Gerlache Strait. The Borchgrevink expedition afterwards found three distinct types of insects at Cape Adare. Scott's party, however, is the first that has noticed insects in any numbers. It is not stated, however, what kind of insects they were, merely that they were half frozen. It would be of interest if they could be compared with the large red brown flies, nearly an inch long, which the Rev. G. F. Browne (*Ice Caves of France and Switzerland,* 1865, pp. 8, 42) saw running rapidly on the ice and stones of the Glacière de la Genolliere, and one of which he also found at the Glacière du Pré de Saint Livres, and which he was told was something very like the *Stenophylax hieroglyphicus* of Stephens.

An interesting zoological discovery was made at the Koettlitz Glacier. This drains off, like many mountain glaciers, through a stream flowing beneath glacier and moraine. But in this case it was found that seals proceeded up this subglacial river, and that their blowholes occurred at intervals along its course. It seems to be a new fact in natural history that seals sometimes go up a subglacial freshwater stream.

It is a lucky thing for science that Scott's expedition started when it did. After the discovery of the South Pole by Amundsen was announced, it would probably have been impossible to finance a scientific expedition to South Victoria Land. Scott's expedition, while not adding greatly to geographical knowledge, has certainly been most helpful to various other branches of science. It has been well handled under great difficulties, and from the scientific standpoint, it has been distinctly successful.

It seems well in this article to record the return of the Japanese expedition to the Antarctic under Lieutenant Shirase, in the *Kainan-Maru.* They left Sydney on November 19, 1911, and sailed straight to the Bay of Whales, where they landed a party and met the *Fram.* Thence they proceeded to Edward Land, where they landed another party, and then did some exploring along the coast. The two shore parties were then picked up and the *Kainan-Maru* returned to Wellington, New Zealand, on March 24, 1912. The details of the journey have not been published as yet.

There are some important facts, principally meteorological, on which the voyages of Amundsen and Scott have shed much light. These facts were known to some extent before now, mainly through the experiences of Nordenskjöld and Charcot. Probably they influenced Amundsen when planning his trip; at any rate they have profoundly affected the actual carrying out of the journeys of both Amundsen and Scott.

We know now that there are at least three great mountain ranges in Antarctica, that of South Victoria Land, that of Amundsen and Edward Land, and the Antarctic Andes of Eastern West Antarctica. These have the decidedly similar geographical characteristics of pointing in a general way from the neighborhood of the South Pole and of radiating towards the periphery of Antarctica much like the spokes of a wheel. Now the point to be noticed is that Scott wintered on the eastern slopes of the great mountain ranges of South Victoria Land, and Nordenskjöld on the eastern slopes of the Antarctic Andes. Amundsen wintered on the western slopes of the great mountain ranges of Edward Land and Amundsen Land, and Charcot on the western slopes of the Antarctic Andes. Nordenskjöld and Scott thus wintered in similar exposures; and Charcot and Amundsen likewise wintered in similar exposures. Scott evidently met extremely bad weather, heavy storms, blizzards, great cold, and Nordenskjöld had exactly the same experience. Amundsen, whilst noting some very low temperatures during the winter, speaks of but little snow and only two moderate storms, and this is much like what Charcot recorded. In other words, Nordenskjöld and Scott had frightful weather: Charcot and Amundsen had relatively good weather.

The inference is inevitable that this state of things prevails all over Antarctica and that the weather is more severe on the eastern slopes than on the western slopes of mountain ranges. Confirmation of this fact is even offered through occurrences noticed on Scott's own expedition. While the Western party was on the western slopes of the mountains surrounding the Farrar and Koettlitz Glaciers they had but little strong wind, although at Cape Evans very bad weather was experienced during the same period. Moreover, this fact tallies also exactly with the fact to which Dr. Hugh Robert Mill once called the writer's attention in a letter, namely, that the navigators who coasted along Antarctica from west to east had better sailing than those whose prows were pointed in the opposite direction.

From the journeys of Nordenskjöld, Charcot, Amundsen and

Scott, therefore, we may deduce with some assurance certain data about Antarctic weather conditions which must inevitably be taken into account in future voyages of exploration to the Antarctic regions. In fact, on the strength of these deductions, a guess may now be hazarded. Lieutenant Filchner is probably wintering somewhere under the lee of Coats Land. For aught we know to the contrary, there may be another range of mountains there pointing towards the South Pole; at any rate, it seems probable that Filchner will have better weather than either Nordenskjöld or Scott, and that this may aid him in breaking a new trail to the South Pole.

SOME GEOGRAPHIC RELATIONS ILLUSTRATED IN THE PRACTICE OF AGRICULTURE*

BY

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The geography underlying agriculture may be viewed from two contrasted viewpoints. The larger problem is of course to consider the distribution of crops in a unit area as related to the climate, surface features, soil, labor supply and markets. For instance, with the climate, surface features and soil all favoring the development of dairying in a given section, whether that dairying shall be for furnishing fresh milk or for making butter or cheese, depends generally on the character and accessibility of the market. The distribution of wheat in the United States is dependent very largely on certain conditions of climate and soil, and the distribution of maize for food is dependent on the same conditions but with varying ratio between the values of the determinants.

The more detailed relations between agriculture and physical conditions, however, are equally interesting and perhaps at first sight less obvious. They are none the less real and important, however. Some of these relations, as seen in agricultural practice in the eastern United States, form the basis of this paper.

Slope and Exposure. In any region of varied relief, with contrasted slopes and exposure to sunlight and wind, agricultural

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* Read before the Association of American Geographers, December, 1910.